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ABSTRACT

This paper identifies five indicators of exemplary efforts and programs that characterize an emerging model for science teacher education reform. These include: (1) defining basic science as content preparation; (2) assessing students beyond content mastery; (3) providing multiple school experiences; (4) working in a semester-long teacher center; and (5) continuing education of cooperating teachers and newly certified teachers. Each indicator is discussed and examples and literature support are given. (CW)

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TOWARD A MODEL SCIENCE TEACHER EDUCATION PROGRAM

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Preparing the science chapter for the new Handbook of Research in Teacher Education has provided some clear indicators for exemplary efforts and programs (Yager & Penick, in press). John Penick has identified five such indicators that include:

1) Developing a Rationale for Teaching Science
2) Teacher Education Across Four Semesters: Providing Sufficient Time for Personal Change
3) Developing Self-Analysis Skills Concerning Teaching and Learning Behaviors
4) Analyzing Classroom Climate
5) Modeling Teaching Behaviors Expected in the New Science Teachers

There are other features of exemplary science teacher education programs which characterize an emerging model for those interested in reform. Five of these features include the following:

1) Defining Basic Science as Content Preparation
2) Assessing Students Beyond Content Mastery
3) Providing Multiple School Experiences
4) Working in a Semester-Long Student Teacher Center
5) Continuing Education of Cooperating Teachers and Newly Certified Teachers

1. Defining Basic Science as Content Preparation. George Gaylord Simpson (1957; 1963) has developed a definition of science which includes the three essential ingredients of the human enterprise. He said:

> "Science is an exploration of the material universe in order to seek orderly explanations (generalizable knowledge) of the objects and

events encountered: but these explanations must be testable."

The science preparation for a teacher of science must include opportunities to develop and follow-up on questions arising from personal exploration. It must include practice with explaining the objects and happenings encountered; it must include creating situations (experiments) designed to test the validity of the explanation offered. All of these ingredients of basic science require personal involvement of the individual. Every student studying science should have experience with questioning, explaining, and testing such explanations. Science cannot be defined by the several disciplines that have been designated by scientists to define better the aspect of their own sciencing (i.e. curiosity, questioning, explaining and testing). Science cannot (and should not) be the mastery of information someone else possesses. Such "mastery" is not real science--and it rarely results in anything other than temporary verbalization about objects and events as seen and known by someone else.

Quantity of science preparation is not a major factor in producing a superior science teacher (Yager, Hidayat, & Penick, 1988). And, college science instructors do not consider the acquisition of content information as important--or even desirable--prior to further study of a particular science (Razali, 1986; Susilo, 1987). There may be more important experiences to include in a program preparing science teachers than 60 semester hours of courses in pure science. Of equal importance to such basic science may be: 1) philosophy of science, 2) history of science, 3) society and science, 4) science and decision-making, 5) science-related issues, 6) current technology, 7) applications of science in daily living, 8) a consideration of careers in science, 9) science/technology and national development. Such materials (courses) should be considered basic content preparation for future science teachers--perhaps to the exclusion of extensive work in advanced courses in basic science areas.

2. Assessing Students Beyond Content Mastery. All the course preparation for future teachers (or students in schools) will be unimportant if assessment of success is measured only in terms of content acquired. Most course examinations test primarily for information that students can repeat and/or recognize as best response on a multiple choice test. Science is more than information; success with it must be assessed in other domains. McCormack and Yager (submitted for publication) have proposed five domains of science learning, which include:

Knowing and Understanding; including facts, concepts, laws (principles), existing explanations and theories, and internalized knowledge;

Exploring and Discovering; including observing and describing, classifying and organizing, measuring and charting, communicating and understanding communications of others, predicting and inferring, hypothesizing, hypothesis testing, identifying and controlling variables, interpreting data, constructing instruments, simple devices, and physical models;

Imagining and Creating; including visualizing - producing mental images, combining objects and ideas in new ways, producing alternate or unusual uses for objects, solving problems and puzzles, fantasizing, pretending, dreaming, designing devices and machines, producing unusual ideas;

Feeling and Valuing; including developing positive attitudes toward science in general, science in school, and science teachers, developing positive attitudes toward oneself (an "I can do it" attitude), exploring human emotions, developing sensitivity to, and respect for, the feelings of other people, expressing personal feelings in a constructive way, making decisions about personal values, making decisions about social and environmental issues;

Using and Applying; including seeing instances of scientific concepts in everyday life experiences, applying learned science concepts and skills to everyday technological problems, understanding scientific and technological principles

involved in household technological devices, using scientific processes in solving problems that occur in everyday life, understanding and evaluating mass media reports of scientific developments, making decisions related to personal health, nutrition, and life style based on knowledge of scientific concepts rather on "hear-say" or emotions, integrating science with other subjects.

The five domains must be a part of a teacher education program and experience with assessing growth in all five domains must be a part of the program. Assessing students in schools in the domains is also important. It is vital if progress is to be made for viewing science in any way other than a unidimensional one; invariably this is the information level and rarely does teacher or student move beyond it.

3. Providing Multiple School Experiences. Central to any teacher education program is the school--the place that teachers are preparing to work. To keep future teachers away from schools except for one exploratory course during one semester and a student teaching semester seems the ultimate folly. The most important part of preparing for any profession is the part that includes work in the environment required of the profession.

Plans in states like Texas to limit the total permissible credit in "education" offerings probably have arisen because so many professional courses are devoid of work in actual schools or perceived relationship to what does go on in schools. Perhaps each professional course should include a laboratory practice based in a school. The most successful student teacher is one who has worked in a school frequently as a part of his/her professional sequence. Some now maintain that teacher education programs should include significant work in a school setting with appropriate seminars, theory, and analysis for at least three semesters prior to student teaching.

4. Working in a Semester-Long Student Teacher Center. Too often student

teaching means an apprenticeship with one practicing teacher. If the teacher education student has completed numerous practicum experiences in schools, he/she is ready for a semester-long experience with a total school staff, program, and facilities. Model programs bring the student teacher to the total school/community. Such student teachers serve as interns--quite different from being an apprentice for one teacher craftsman.

In such a student teaching center, each student teacher will:

1. Work for a significant period of time with at least five master teachers;
2. Work for the entire semester in no more than two classrooms with his/her lead/anchor teacher;
3. Teach in a variety of science/mathematics disciplines (all for which he/she will be certified);
4. Teach at multiple 7-12 grade levels;
5. Head a major out-of-school activity with students;
6. Become involved with one or more school or community betterment projects;
7. Develop a new teaching module with two or more cooperating teachers for some facet of the particular school science program.

Student teaching in a model program becomes a semester long internship with direct experience with a variety of teachers in a single school system as well as other school/community officials. Such a program will bring school professionals into a collegial association with each other and with the college/university teacher education staff.

5. Continuing Education of Cooperating Teachers and Newly Certified Teachers. A model science teaching program casts science teaching into a scientific mold versus an artistic one. Science teaching is a continuing/changing

enterprise just like science itself. Too many describe science as an art--i.e., something developed for all to admire and to practice. Goals are ever changing; problems are newly defined and stated; needs change. Science curricula change as do instructional strategies to deal with them.

A major problem in teacher education and certification programs in many states is the view that a teacher is created at the end of a preparatory program, that a certificate provides license for continuing teaching practice. A model program includes college/university staff members, cooperating teachers, school/community leaders, and the teacher education students who are model learners. Educators ideally are model learners; they strive to learn and to learn how they learn; they study such processes that can improve their skills as a teacher; i.e. a learner stimulator.

The ties between preservice staff (and the students enrolled) and the world of inservice teachers are loose at best. In model teacher education programs these ties become increasingly stronger.

The model of science teacher education is at odds with many current developments in states and with recommendations of such prestigious efforts as those outlined by the Holmes Group and the Carnegie Commission. These groups have urged limits on the professional preparation and have often called for fifth year programs. This would mean that all would-be teachers would complete standard Liberal Arts degrees. Their educational/professional preparation would occur in but two semesters of work beyond the Bachelor's Degree.

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